



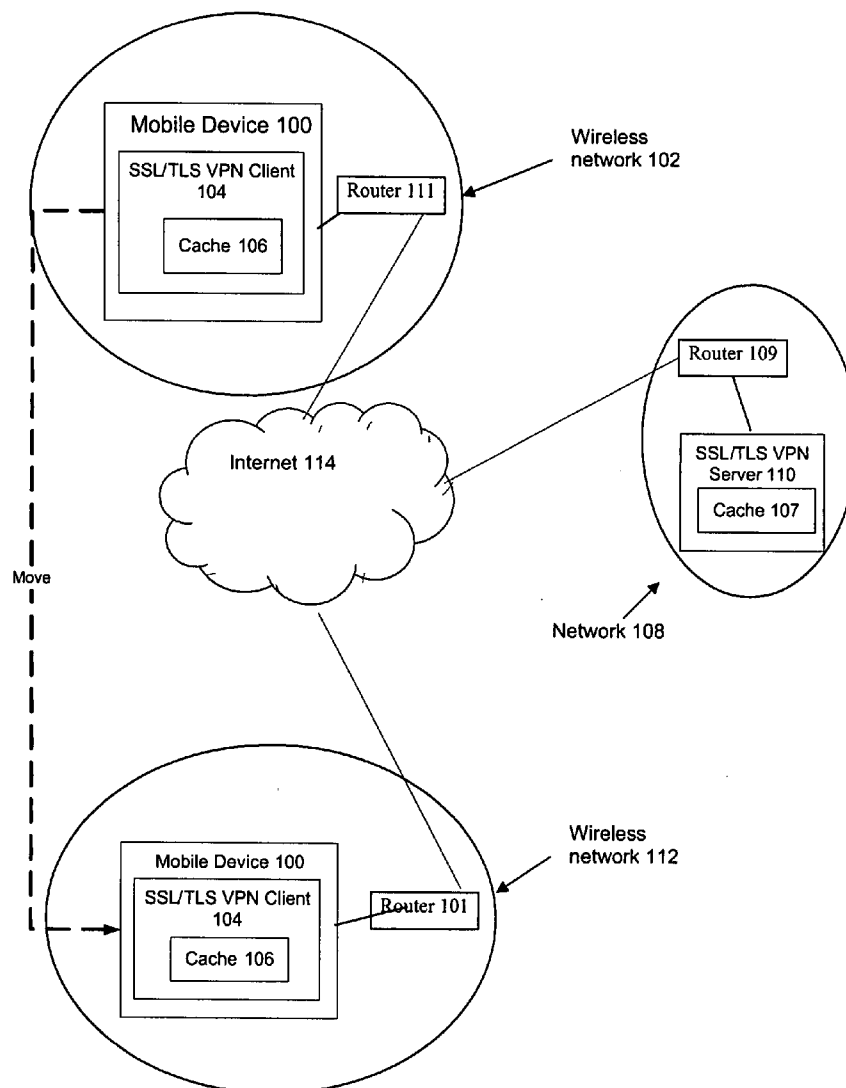
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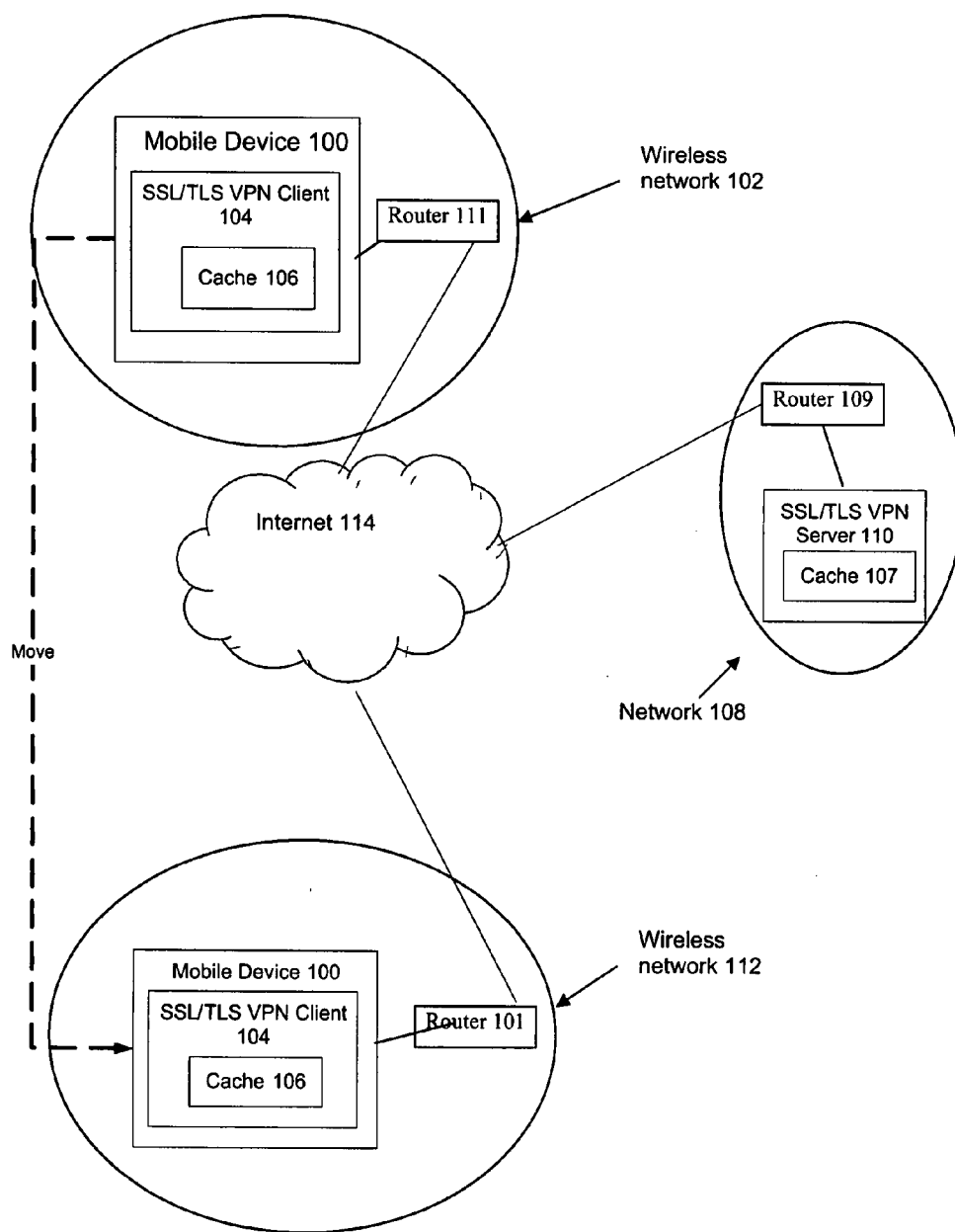
(19) **United States**(12) **Patent Application Publication****Song et al.**(10) **Pub. No.: US 2007/0218912 A1**(43) **Pub. Date: Sep. 20, 2007**(54) **METHOD AND SYSTEM FOR MOBILE  
SECURE SOCKET LAYER IN VIRTUAL  
PRIVATE NETWORKS**(75) Inventors: **Yu Song**, Pleasanton, CA (US);  
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Suwon City (KR)(21) Appl. No.: **11/725,380**(22) Filed: **Mar. 19, 2007****Related U.S. Application Data**(60) Provisional application No. 60/784,330, filed on Mar.  
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**H04Q 7/20** (2006.01)(52) **U.S. Cl.** ..... **455/445**(57) **ABSTRACT**

A communication method and system enables a mobile device to establish and maintain a secure connection to a server in a target network via connecting networks. The connection is maintained even when the mobile device hands off (moves) from one connecting network to another connecting network.





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FIG. 1

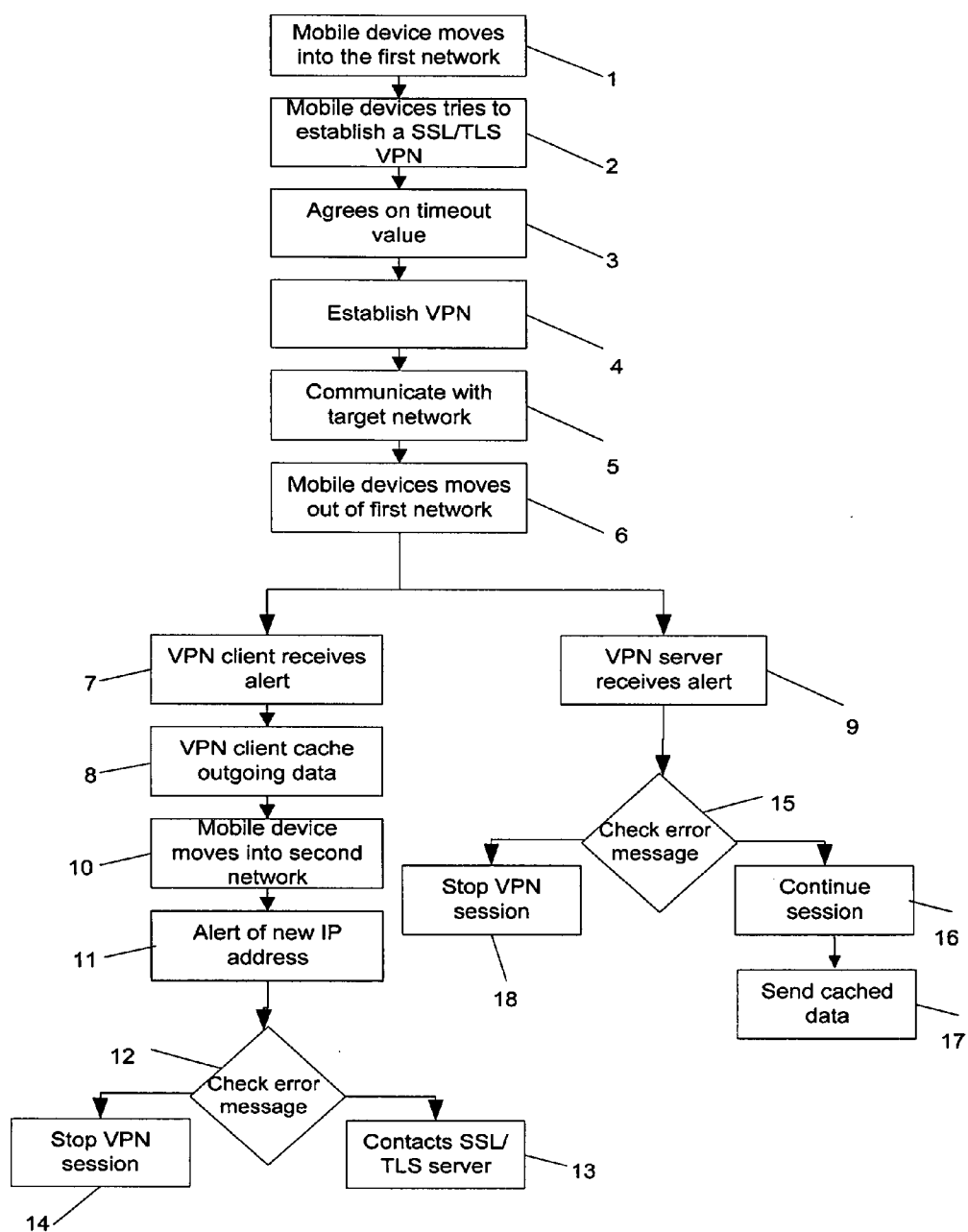
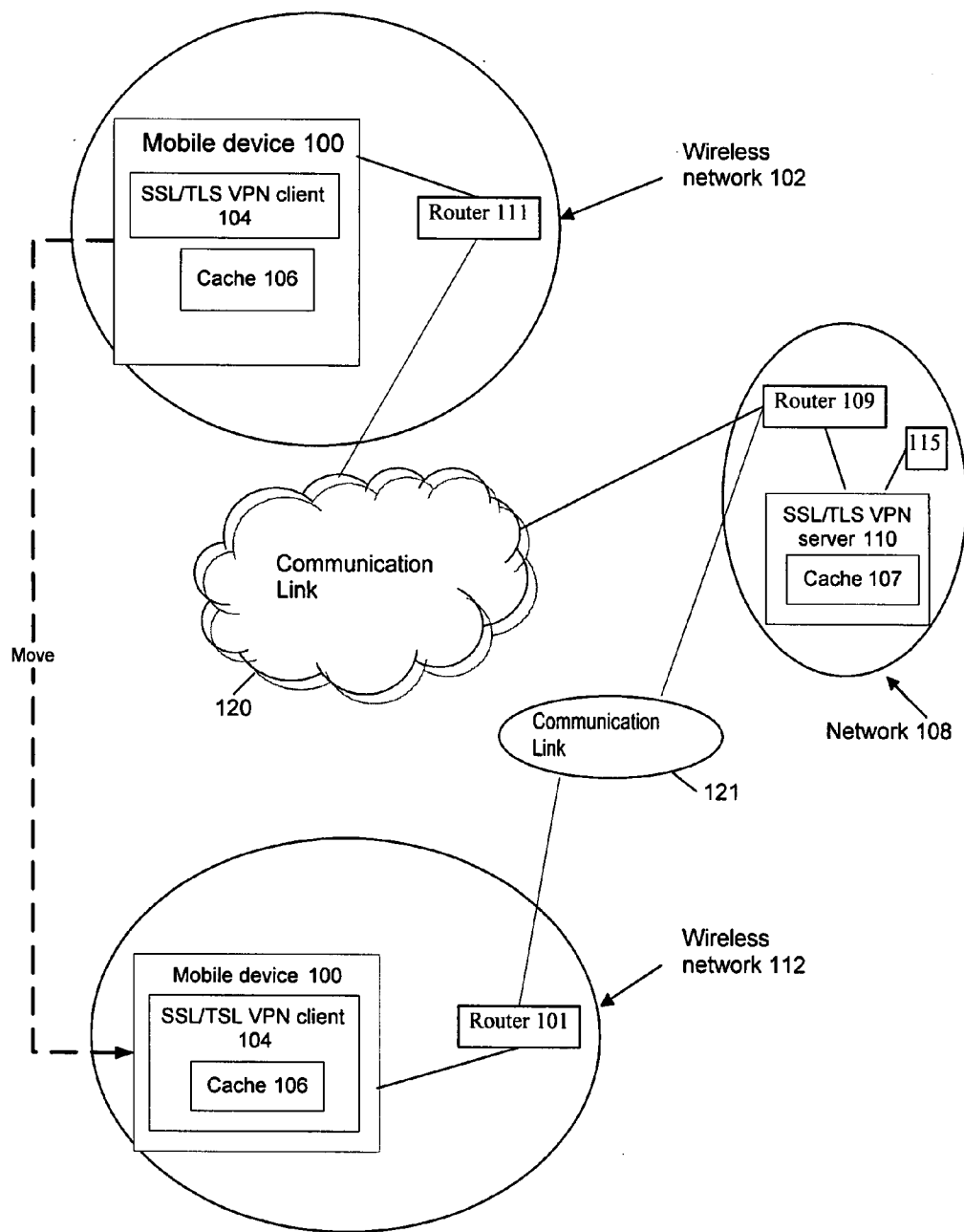


FIG. 2



200

FIG. 3

## METHOD AND SYSTEM FOR MOBILE SECURE SOCKET LAYER IN VIRTUAL PRIVATE NETWORKS

### RELATED APPLICATION

[0001] This application claims priority from U.S. Provisional Patent Application Ser. No. 60/784,330, filed Mar. 20, 2006 incorporated herein by reference.

### FIELD OF THE INVENTION

[0002] The present invention relates to mobile secure networks, and in particular, to mobile device secure connection in virtual private networks.

### BACKGROUND OF THE INVENTION

[0003] Mobile wireless devices with connectivity to wireless networks such as cellular networks and IEEE 802.11x (WiFi) networks are increasing in popularity. Ideally, mobile devices allow users to connect to their target network from anywhere, at anytime. The virtual private network (VPN) approach has been the dominant choice for secure connectivity between mobile wireless devices and networks.

[0004] Unlike stationary devices, mobile devices move from one network to another network. As such, a mobile device's network attachment is not fixed. Depending on the location of the mobile device and the available wireless networks in its vicinity, a mobile device can attach to different networks at different times.

[0005] In the Internet Protocol version 4 (IPv4) network infrastructure, each time a mobile device attaches to a network, the mobile device receives a different network address. Such mobility, however, breaks the VPN connection because a VPN connection assumes that the VPN endpoints (i.e., the VPN client and the VPN server) have persistent IP addresses. For a mobile wireless device, the VPN client IP address changes during network handoff from one wireless network to another.

[0006] To overcome this problem, a conventional approach has been to use Internet Protocol Security (IPSec) over a Mobile IP tunnel, which assumes that the mobile wireless device has a mobile IP address as opposed to a regular IP address. The mobile IP address does not change when a mobile wireless device moves from one network to another network, and therefore, the mobile wireless device has a persistent IP address. This approach uses IPSec VPN technology to establish a VPN over the mobile IP.

[0007] Such an approach, however, has several disadvantages. The first disadvantage is that it is tied to a specific IP technology, namely, the mobile IP. With the slow adoption of mobile IP, a large number of the mobile wireless devices will not have mobile IP in the foreseeable future. The second disadvantage is that such an approach requires a particular VPN technology, namely, the IPSec VPN. IPSec VPN requires each mobile wireless device to have the IPSec in the operating system kernel, which is difficult to configure. The third disadvantage of such an approach is that using tunnels is inefficient and difficult to manage.

[0008] A technical trend in the VPN technology has been to use Secure Socket Layer/Transport Layer Security (SSL/TLS) as the base for the VPN connection. A SSL/TLS VPN establishes a VPN over a SSL/TLS connection. The current SSL/TLS VPN connection breaks when a mobile device moves from one network to another, because the SSL/TLS

connection is lost when a mobile wireless device moves out of a network, and therefore, a new SSL/TLS connection must be established when the mobile wireless device moves into another network.

[0009] A conventional approach for maintaining a connection between a VPN server and a mobile device is to use a migratable socket. A migratable socket maintains an open socket regardless of the mobile device's network attaching point. Once the socket is maintained, upper layer protocols, such as SSL/TLS can be maintained as well.

[0010] However, this approach requires the additional functionalities of a network router, as illustrated by an example herein. Assume that a mobile wireless device in a wireless network A establishes a VPN connection to its home network (e.g., network C), and at a later time, the mobile device moves from the wireless network A to another wireless network B while keeping the VPN open. To accomplish this, a router in the wireless network A must forward packets from the network C to the router in the wireless network B such that from the socket's point of view, the connection is still open. This approach requires the additional functionalities of the network router. There is, therefore, a need for a method and system for secure connection of mobile devices to VPN wireless networks.

### BRIEF SUMMARY OF THE INVENTION

[0011] The present invention provides a method and system that enable communication for a mobile device, by establishing a secure connection between the mobile device and a server in a target network via a connecting network, which is connected to the target network via a communication medium. The secure connection between the mobile device and the server in the target network is maintained when the mobile device hands off from the connecting network to another connecting network which is connected to the target network via a communication medium.

[0012] In one implementation, the present invention enables the mobile device to maintain a secure connection such as a SSL/TLS VPN session to a server in the target network when the mobile device hands off (moves) from one connecting network to another connecting network. The output packets from a client in the mobile device to the server are cached during handoff to a new network. Then, upon handoff, a resume feature of the server is used by the client to resume the session with the server via the new network, instead of establishing a new session.

[0013] As such, the present invention allows maintaining a VPN connection for mobile device handoff between networks. This is achieved using a mobile secure socket layer in a VPN network. Such a secure socket layer enables a mobile device to maintain a SSL/TLS VPN connection to a network when the mobile device hands off (moves) from one network to another network on the Internet, despite differing network attachments at different times. In one example, implementation, the output packets from a mobile device (SSL/TLS client) to a VPN server are cached during the network handoff. Further, the resume feature of the SSL/TLS protocol is utilized such that when a mobile device moves to a new network, the SSL/TLS client resumes the SSL/TLS session instead of establishing a new session.

[0014] These and other features, aspects and advantages of the present invention will become understood with reference to the following description, appended claims and accompanying figures.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 shows a functional block diagram of a system implementing a mobile secure socket layer, according to an embodiment of the present invention.

[0016] FIG. 2 shows a flowchart of a process for maintaining a VPN connection for a mobile device while it moves from one network to another network, according to an embodiment of the present invention.

[0017] FIG. 3 shows a functional block diagram of another system implementing a mobile secure socket layer, according to an embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0018] The present invention provides a method and system for maintaining a VPN connection for mobile device handoff between networks. This is achieved using a mobile secure socket layer in a VPN network. In one embodiment, such a method and system enable a mobile device (wireless or otherwise) to maintain a SSL/TLS VPN connection to a network when the mobile device hands off from one network to another network on the Internet.

[0019] FIG. 1 shows a system 90 including a VPN client 104 in a mobile device 100, and a VPN communication module server 110 implementing a SSL/TLS VPN server function, in a target network 108. The client 104 and the communication server 110 enable the mobile device 100 to establish and maintain a SSL/TLS VPN connection with the communication server 110, when the mobile device 100 hands off from one connecting network 102 to another connecting network 112.

[0020] The system 90 implements a mobile secure socket layer, according to an embodiment of the present invention. The mobile device 100 connects to the first (connecting) network 102 and obtains an IP address from the network 102. The mobile device 100 includes the SSL/TLS client 104, according to the present invention, which establishes and maintains a SSL/TLS connection session with the SSL/TLS VPN server 110, also according to the present invention. The SSL/TLS client 104 includes a cache 106 that maintains data sent out from the SSL/TLS client 104 during temporary network loss.

[0021] In the example system 90, the SSL/TLS server 110 is in the second (target) network 108. The SSL/TLS server 110 allows the SSL/TLS client 104 to establish a VPN connection to the network 108, and maintain the VPN connection during the migration of the SSL/TLS client 104 from the network 102 to the third (connecting) network 112 (as shown by the dashed line with an arrow). The SSL/TLS server 110 also includes a cache 107 to maintain data sent out from the SSL/TLS server 110 when a connection to the SSL/TLS client 104 is temporarily lost.

[0022] The networks 102, 108 and 112 can be any type of networks, such as Ethernet, WiFi, cellular networks, with at least a conventional network router (i.e., a router 101 in the network 102, a router 111 in the network 112 and a router 109 in the network 108). The networks 102, 108 and 112 are connected via the Internet 114. The connections between the

networks 102, 108 and 112 and the Internet 114 can be wide area networks, such as DSL, cable, TI, etc. The networks 102, 108, 112 can be wired or wireless networks.

[0023] The mobile device 100 can communicate with each of the networks 102 and 112 over a network medium, such as WiFi, a cellular network, Ethernet. In turn, the connecting networks 102 and 112 communicate with the target network 108 via the Internet 114. When communicating with the network 102, the mobile device 100 can establish communication with the target network 108 via the network 102 (and the Internet 114). When communicating with the network 114, the mobile device 100 can establish communication with the target network 108 via the network 112 (and the Internet 114).

[0024] The SSL/TLS VPN connection session between the mobile device 100 and the target network 108 (e.g., a home network, an enterprise network) is maintained when the mobile device 100 hands off (moves) from the connecting network 102 to the connecting network 112.

[0025] FIG. 2 shows a flowchart of a SSL process implemented in the system 90 of FIG. 1, including the steps of:

[0026] 1. The mobile device 100 moves into the first wireless network 102, establishes communication with the conventional router 111, and is assigned a private IPv4 address in the network 102.

[0027] 2. The client 104 in the mobile device 100 contacts the SSL/TLS VPN server 110 in the target network 108 via the network 102 and the Internet 114), to try to establish a VPN connection session using the enhanced TLS/SSL handshaking process (i.e., standard handshaking and timeout value agreement) and VPN establishing process.

[0028] 3. During the TLS/SSL handshaking between the SSL/TLS VPN client 104 and the SSL/TLS VPN server 110, in addition to the standard TLS/SSL, the client 104 and the server 110 agree on a timeout value (timeout period). The timeout value determines the length of time the cache 106 stores the outgoing data from the SSL/TLS VPN client 104 to the SSL/TLS VPN server 110 during a hand off to the network 112 that causes a connection loss between the client 104 and the network 102. The timeout value also determines the length of time the cache 107 stores the outgoing data from the SSL/TLS VPN server 110 to the TLS/SSL VPN client 104 during such a connection loss.

[0029] 4. After TLS/SSL handshaking, the SSL/TLS VPN client 104 establishes a TLS/SSL session with the SSL/TLS VPN server 110, and receives a TLS/SSL session ID, which is a unique identification described in the standard TLS/SSL specification. Once the TLS/SSL session is established, the VPN client 104 and SSL/TLS VPN server 110 proceed to establish a VPN on top of the established TLS/SSL session with standard VPN procedure.

[0030] 5. The mobile device 100 can then communicate with the TLS/SSL VPN server 110 within the target network 108, via the network 102 and the Internet 114.

[0031] 6. At a later time, the mobile device 100 moves out of the first wireless network 102, wherein the connection to the first wireless network 102 is lost.

[0032] 7. The SSL/TLS VPN client 104 receives an alert message from the network stack, such as TCP/IP stack, on the device 100, indicating that the client 104

has lost connection to the network 102. The client 104 starts a timer with said agreed upon timeout value.

[0033] 8. The mobile device 100 can continue to send data to the TLS/SSL VPN server 110 in the network 108. However, such data is cached by the cache 106 in the client 104. The cache 106 temporarily caches the outgoing data until the timer times out, at which time, if the mobile device 100 has not resumed the VPN session with the TLS/SSL VPN server 110 (e.g., via another connecting network) the cache 106 clears the temporary data and informs the SSL/TLS VPN client 104 of a fatal error. As such, when the timer expires and the mobile device 100 has not resumed the VPN session with the TLS/SSL VPN server 110, the VPN session is considered to be lost, and data in the cache 106 is flushed.

[0034] 9. When the mobile device 100 moves out of the first wireless network 102, at the same time the SSL/TLS server 110 also receives an alert from its network stack, such as the TCP/IP stack, on the server 110, about the connection loss with the client 104, and starts a timer with said agreed upon timeout value. The SSL/TLS server 110 in the network 108 can continue to send data to the mobile device 100. That data is cached by the cache 107. The cache 107 temporarily caches the outgoing data until the timer times out, at which time, if the session between the server 110 and the client 104 has not resumed (e.g., via another connecting network), then the cache 107 clears the temporary data and informs the SSL/TLS server 110 of the fatal error.

[0035] 10. When the mobile device 100 moves into the network 112, the client 104 establishes communication with the network 112 and a new private IPv4 address for the client 104 in the network 112 is provided by the conventional router 101.

[0036] 11. The SSL/TLS client 104 receives an alert from its network stack, such as the TCP/IP stack, indicating the availability of the new IP address (i.e., IPv4 address).

[0037] 12. The SSL/TLS client 104 checks whether it has received a fatal error message due to a time out on its own cache 106.

[0038] 13. If the SSL/TLS VPN client 104 has not received such fatal error message, the client 104 contacts the SSL/TLS VPN server 110 in the target network 108 and sends the session ID obtained in step 4, and issues a session resumption request to resume the VPN session using known SSL/TLS standard. The present invention does not require change to the standard VPN establishing handshaking, and in the SSL handshaking in this example the present invention utilizes the standard SSL resume request for SSL session resumption, and provides the additional features of exchange timeout, and caching according to the present invention.

[0039] 14. Otherwise, if the SSL/TLS VPN client 104 has received such fatal error message, then the SSL/TLS VPN client 104 stops the VPN session and informs the mobile device 100 that the VPN session is lost and needs to be re-established (e.g., via the network 112).

[0040] 15. When the SSL/TLS VPN server 110 receives the session resumption request and session ID from the

SSL/TLS VPN client 104 in step 13 above, the server 110 checks if it has received a fatal error message from its own cache 107.

[0041] 16. If the SSL/TLS server 110 has not received such fatal error message, the server 110 continues (resumes) the TLS/SSL session with the SSL/TLS VPN client 104 and may renegotiate new session keys/IDs. Once the TLS/SSL session has been resumed, the server 110 and the client 104 proceed to re-establish the VPN session using the same information obtained in step 4, such as assigning VPN IP addresses to both server 110, client 104, setting up routing tables in both server 110, client 104

[0042] 17. Once the existing session is resumed, the SSL/TLS VPN client 104 and the SSL/TLS VPN server 110 each sends out the cache data in their respective caches 106 and 107 to their intended recipients, and clears their cache contents. As such, the client 104 sends to the server 110 those packets in the cache 106 that were intended for the network 108, via the connecting network 112 and the Internet 114. Further, the server 110 sends out those packets in the cache 107 that were intended for the mobile device 100, via the Internet 114 and the connecting network 112.

[0043] 18. If the SSL/TLS VPN server 110 has received a fatal error message, the server 110 rejects the session resumption request from the SSL/TLS VPN client 104 in step 14, and forces the client 104 to re-establish a VPN connection with the server 110.

[0044] Accordingly, the present invention enables the mobile device 100 to maintain a SSL/TLS VPN despite differing network attachments at different times. The outbound packets from the client 104 in the mobile device 100 to a VPN server 110 in the network 108 are cached during the network handoff when the mobile device 100 moves from the network 102 to the network 112.

[0045] Likewise, during the handoff, the outbound packets from the sever 110 in the target network 108, to the client 104 in the mobile device 100, are cached in the cache 107 (i.e., the packets in the caches 106 and 107 are sent to their intended recipients once the handoff is successfully completed).

[0046] The resume feature of the SSL/TLS protocol is utilized such that when the mobile device 100 moves (hands off) from the network 102 to the network 112, the SSL/TLS client 104 in the mobile device 100 resumes the SSL/TLS session with the server 110 in the target network 108, instead of establishing a new session.

[0047] As such, the present invention enables maintaining a mobile SSL/TLS VPN connection (session) between the mobile device 100 and the network 108, when the mobile device 100 hands off (moves) from the network 102 to the network 112.

[0048] Further, the present invention does not require changes to the current IPv4 network infrastructure, and operates with the proven SSL/TLS protocol with no change.

[0049] Though in the example implementation shown in FIG. 1 the Internet 114 is shown as the communication medium between the connecting network 102 and the target network 108, the present invention is not limited to such implementations. As such, the network 102 can be connected to the target network 108 by other communication medium such as, e.g., wired, wireless, optical, other networks, or combinations thereof. Further, though in the

example implementation shown in FIG. 1 the Internet 114 is shown as the communication medium between the connecting network 112 and the target network 108, the present invention is not limited to such implementations. As such, the network 112 can be connected to the target network 108 by other communication medium, such as, e.g., wired, wireless, optical, other networks, or combinations thereof. Further, the communication medium between the network 102 and the network 108 can be different from the communication medium between the network 112 and the network 108.

[0050] FIG. 3 shows a functional block diagram of another system 200 implementing a mobile secure socket layer, according to an embodiment of the present invention. In the system 200, the network 108 includes at least one SSL/TLS server 110 which the mobile device 100 communicates with via the VPN session established, and maintained, between the client 104 and the server 110. The network 102 shows a SSL/TLS VPN client 104 which allows the mobile device 100 to connect to the server 110 for establishing a SSL/TLS VPN session with the server 110 via the network 102 and a communication link 120.

[0051] The network 112 shows a SSL/TLS VPN client 104 which allows the mobile device 100 to connect to the server 110 for establishing a SSL/TLS VPN session with the server 110 via the network 112 and a communication link 120. The communication link 120 may be of the same type, or a different type, than the communication link 121.

[0052] As is known to those skilled in the art, the aforementioned example architectures described above, according to the present invention, can be implemented in many ways, such as program instructions for execution by a processor, as logic circuits, as an application specific integrated circuit, as firmware, etc. The present invention has been described in considerable detail with reference to certain preferred versions thereof; however, other versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained herein.

What is claimed is:

1. A method of communication for a mobile device, comprising the steps of:
  - establishing a secure connection between a mobile device and a first network;
  - establishing a secure connection between the mobile device and a communication server in a second network via the first network which is connected to the second network by a communication medium; and
  - maintaining the secure connection between a mobile device and the server in the second network when the mobile device hands off from the first network to a third network which is connected to the second network via a communication medium.
2. The method of claim 1 wherein said communication medium comprises the Internet.
3. The method of claim 2 further comprising the step of: a mobile device communicating with a first network via a wireless medium, and in turn the first network communicating with the server in a second network over a communication medium.
4. The method of claim 3 wherein the mobile connection between the mobile device and the server in the second network comprises a SSL/TLS VPN session.

5. The method of claim 4 wherein:

the step of the mobile device communicating with the first network includes the mobile device obtaining an IP address in the first network; and

the client comprises a SSL/TLS VPN client and the server comprises a SSL/TLS VPN server, such that the step of the mobile device establishing a connection with the server in the second network further includes: the SSL/TLS VPN client in the mobile device contacting the SSL/TLS VPN server in the second network via the first network to establish a VPN session.

6. The method of claim 5 further comprising the steps of: upon hand off from the first network to the third network, the mobile device establishing communication with the third network; and

the mobile device maintaining the session with the server in the second network when the mobile device hands off from the first network to the third network.

7. The method of claim 6 further comprising the steps of: upon loss of connection with the server via the first network, the client in the mobile device caching outgoing packets for a first time period; and

upon loss of connection with the mobile device via the first network, the server in the second network caching outgoing packets to the mobile device for a second time period.

8. The method of claim 7 wherein the step of the mobile device establishing communication with the third network further includes the step of the mobile device obtaining an IP address in the third network.

9. The method of claim 8 further comprising the steps of: while the first time period has not expired, the client in the mobile device contacting the server in the second network via the third network, and using a session resumption request;

otherwise if the first time period expired, then the client in the mobile device stopping the VPN session with the server in the second network.

10. The method of claim 9 further comprising the steps of: upon receiving a resumption request, the server in the second network determining if the second time period expired, such that:

if the second time period has not expired, then the server in the second network resumes the SSL/TLS VPN session with the client in the mobile device, and sends the respective cached packets to their intended recipients;

otherwise, if the second time period has expired, then the server in the second network rejecting the session resumption request and forcing the client to re-establish a VPN session with the server in the second network.

11. A system for mobile communication between a mobile device and a target network via connecting networks, comprising:

a client module in the mobile device, the client module configured to establish a connection to a first connecting network, and further establish a secured mobile connection between the mobile device and the target network via the first connecting network; and

a server module in the target network, the server module configured to establish a secured mobile connection with the client module via the first connecting network;



wherein the client module is further configured to maintain a secure mobile connection between the mobile device and the target network if the mobile device hands off from the first connecting network to a second connecting network.

**12.** The system of claim **11** wherein the first connecting network and the target network are connected via a communication link, and the target network and the second connecting network are connected via a communication link.

**13.** The system of claim **12** wherein said secure connection between the client module in the mobile device and the server module in the target network comprises a SSL/TLS session.

**14.** The system of claim **13** wherein the mobile connection between the client module in the mobile device and the server module in the target network comprises a SSL/TLS VPN connection.

**15.** The system of claim **14** wherein:

the client module is configured to communicate with the first connecting network to obtain an IP address in the first connecting network; and

the client module comprises a SSL/TLS VPN client and the server module comprises a SSL/TLS VPN server, wherein the SSL/TLS VPN client and the SSL/TLS VPN server are configured to communicate via the first network for establishing a VPN session, and maintain the session between the client module and the server module upon handoff of the mobile device from the first connecting network to the second connecting network.

**16.** The system of claim **15** wherein the client module is configured such that if the mobile device hands off to the second connecting network, the client module establishes communication with the second connecting network.

**17.** The system of claim **16** wherein:

the mobile device includes a cache and the client module is configured such that upon loss of connection with the server for hand off, the client module caches outgoing packets to the server in the target network, for a first time period; and

the server module includes a cache, and the server module is further configured such that upon loss of connection with the mobile device, the server caches outgoing packets to the mobile device, for a second time period.

**18.** The system of claim **17** wherein the client module is further configured to establish communication with the second connecting network by obtaining an IP address in the second connecting network.

**19.** The system of claim **18** wherein the client module is configured such that:

if the first time period has not yet expired, then the client module contacts the server module via the second connecting network, and issues a session resumption request to the server module;

otherwise, if the first time period has expired, then the client module stops the VPN session with the server module.

**20.** The system of claim **19** wherein the server module is configured such that upon receiving the resumption request, the server module determines if the second time period expired, wherein:

if the second time period has not expired, then the server module resumes the SSL/TLS VPN session with the

client in the mobile device via the second connecting network, and sends the respective cached packets to their intended recipients;

otherwise, if the second time period has expired, then the server module rejects the session resumption request and forces the client module to re-establish a VPN session with the server module.

**21.** A mobile communication device, comprising:

a client module configured to establish communication with a first connecting network, and further establish a secured mobile communication session between the mobile device and a target module via the first connecting network; and

a cache for caching outgoing packets;

wherein the client module is further configured to maintain the secured mobile communication session between the mobile device and the target module if the mobile device hands off from the first connecting network to a second connecting network, by caching one or more outgoing packets to the target module during hand off to the second connecting network.

**22.** The mobile communication device of claim **21** wherein the client module caches one or more outgoing packets to the target module for a first time period, and upon hand off to the second connecting network from the first connecting network, if the first time period has not yet expired, then the client module contacts the target module via the second connecting network, and issues a session resumption request to the target module to resume the communication session and provide the cached packets to the target module.

**23.** The mobile communication device of claim **22** wherein the first connecting network and the target module are connected via a communication link, and the target module and the second connecting network are connected via a communication link.

**24.** The mobile communication device of claim **23** wherein said secured communication session between the client module and the target module comprises a SSL/TLS session.

**25.** The mobile communication device of claim **24** wherein said secured communication session between the client module and the target module comprises a SSL/TLS VPN session.

**26.** The mobile communication device of claim **25** wherein:

the client module is configured to communicate with the first connecting network to obtain an IP address in the first connecting network; and

the client module comprises a SSL/TLS VPN client configured to communicate with the target module via the first connecting network to establish a VPN session.

**27.** The mobile communication device of claim **26** wherein the client module is configured such that if the mobile communication device hands off from the first connecting network to the second connecting network, the client module resumes the session with the target module via the second connecting network.

**28.** The mobile communication device of claim **27** wherein the client module is further configured to establish communication with the second connecting network by obtaining an IP address in the second connecting network.

**29.** The mobile communication device of claim **28** wherein the client module is configured such that:

if the first time period has not yet expired, then the client module contacts the server module via the second connecting network, and issues a session resumption request to the server module;

otherwise, if the first time period has expired, then the client module stops the VPN session with the server module.

**30.** The mobile communication device of claim **21** wherein the target module comprises a server module.

**31.** The mobile communication device of claim **21** wherein the target module comprises a server module in a target network.

**32.** An apparatus for establishing mobile communication with a mobile device via connecting networks, comprising:

a communication server configured to establish a secured mobile connection session with a mobile via a first connecting network; and

a cache for caching outgoing packets;

wherein the client module is further configured to maintain the secured mobile communication session if the mobile device hands off from the first connecting network to a second connecting network, by caching one or more outgoing packets to the mobile device during hand off of the mobile device to the second connecting network.

**33.** The apparatus of claim **32** wherein the first connecting network and the communication server are connected via a communication link, and the communication server and the second connecting network are connected via a communication link.

**34.** The apparatus of claim **33** wherein said secure connection between the mobile device and the communication comprises a SSL/TLS session.

**35.** The apparatus of claim **34** wherein a SSL/TLS session comprises a SSL/TLS VPN connection.

**36.** The apparatus of claim **35** wherein:

the communication server comprises a SSL/TLS VPN server configured to communicate with the mobile device via the first connecting network for establishing a VPN session with the mobile device, and to maintain the VPN session upon hand off of the mobile device from the first connecting network to the second connecting network.

**37.** The apparatus of claim **36** wherein the communication server is further configured such that upon loss of connection with the mobile device, the server in the communication server caches outgoing packets to the mobile device, for a time period.

**38.** The apparatus of claim **37** wherein the communication server is further configured such that upon receiving a session resumption request from the mobile device via the second connecting network, the server module determines if the time period expired, wherein:

if the time period has not expired, then the communication server resumes the SSL/TLS VPN session with the mobile device via the second connecting network, and sends the respective cached packets to their intended recipients;

otherwise, if the time period has expired, then the communication server rejects the session resumption request.

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